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Sole Applicant/Sole Inventor: David Andrew D'Zmura (pro se independent inventor)
Group Art Unit: 3628
Examiner: Mr. Frantzy Poinvil

Appendix: Mark-up Copy of Amendments

Dear Mr. Poinvil:

The following amendments are made respective my substitute specification of 8/9/01:

Prior to the First Paragraph, line 1 of page 3, commencing "DESCRIPTION OF THE DRAWINGS", please add the following new paragraphs and section:

BACKGROUND

The invention is necessitated by the shortcomings evident in prior art financial theories, methodologies, practices and products. The present invention affords improvements.

Prior art financial valuation rests on a pricing relation between coupon, yield to maturity and time to maturity, wherein the price is equal to a valuation formula based on a summation. This summation form creates a problem in derivation, as the first derivative, which should capture the change in price with respect to the yield, is actually only a first order term of the Taylor series approximation needed to find such a solution. Thus, the second derivative, which should capture the change in the change in price with respect to yield, is actually the second order term of the Taylor series approximation. Only by an infinite number of ordered terms does the solution become precise. The first derivative, duration, in the prior

art, the first order term, is positive in magnitude, and hence fails to capture the negative magnitude of Einstein's fourth dimension, duration. Further, the prior art duration formulation contains four variables: coupon, yield, maturity and price, wherein price and yield are related by definition, and hence, the prior art formulation involves an analytic tautology, as price is defined as related to coupon, yield and maturity. Thus, prior art fails to deliver a precise algorithm for duration or to reflect space-time science. The present invention identifies a non-summation form and therefrom derives a precise first (and second) derivative.

When applied to valuation, and valuation changes over time, the prior art process is demonstrably imprecise, which often leads to tragic error when relied upon, as it is, in the hedging of securities and portfolios. And because the nature of imprecision can over or understate the actual change in pricing, when implemented within a portfolio comprising many securities, the error of each can become diffuse in the group and can lead to calamity.

The invention provides innovative algorithms for valuing financial securities, wherein the price (P) of a security relates to three variables via a function, said securities include the group of fixed-income, equity and premium policy instruments, said variables comprising the cash receipts (C), yield (Y) and time (T) to maturity or expiration, said function relating change in price with respect to yield, at instantaneous condition, by a novel formulation of duration. The invention's duration is a perfect form first derivative based on a non-summation formulation of price respective C, Y and T, and hence, is an exact conveyance of change in price with respect to Y in continuous time. The invention's duration is isomorphic to Einstein's postulation of the fourth dimension respective three dimensions of the space-time continuum, also called duration, which he shows as bearing negative magnitude. The

invention's formulation of three variables, C, Y, T, embodies the characteristics of any financial security, and has continuous relation via a fourth dimension, duration, termed K.

In discrete time, the notion of theta, the derivative with respect to increments in time, is described and is implemented in valuation mechanics and in drawings and spreadsheets. The processes accurately and precisely capture price change respective to time and yield.

The invention presents its governing yield which is the spot yield of a security or payment at present or future time. This notion can replace prior art forward rate curve process, this latter process bearing two serious flaws: 1) it is not a continuous curve, but a series of short hyperbolae strung together and joined where each asymptotically explodes; 2) the prior art forward rate curve is not isomorphic to or indicative of pricing realized forward.

The invention relates portfolio aggregation methodologies which afford the establishment of valuation and sensitivity values for a portfolio as a whole, useful in trading and hedging. A variable is specified, Yield M, useful for a portfolio of one or more securities.

The invention specifies algorithms, processes and systems which provide the computation of the novel financial methods. In addition, it specifies arbitrage based thereon, as well as a fixed-income mutual fund utilizing the relative value arbitrage afforded thereby.

The assortment of available financial instruments is limited, and often, what is available, with respect to a sought after duration (for instance, for immunization of a portfolio) may not be available in the market. To such ends, and as means for creating securities which may be alternatives or arbitrage matches for existing securities, the invention creates a new class of financial security, called a Replicated Equivalent Primary Security.

Most of the valuation methods and algorithms used in the pricing of options and derivatives rely on a set of assumptions regarding the log normal condition of the underlying

variables. The invention provides data cleaning techniques to identity and to test for such log normal states of a variable, which are necessary as the conditions of the underlying change. The invention provides data analysis methods and process for small sample environments.

The data cleaning technology is applied to financial variables found in depository banking and P&C insurance industries. Such variables, having nominal value, can function as the underlying variables of financial securities modeled thereon, and therefore, the invention organizes and describes the technology pertaining to underlying state, theta, variables. The invention further specifies a process useful in establishing the likelihood of default of insured depository banks. As the insured banks pay a fee to the FDIC Bank Insurance Fund, such process, utilizing a set of operating ratios in concert, can be helpful in identifying the causes of default risk, as well as assessing the level of risk on an aggregate or individual bank basis. Included in modeling a theta variable is described its mathematical programming functions.

Pursuant to the mechanics of prior art OAS (Option Adjusted Spread) and martingale valuation lattice, useful for modeling values having an element of default or loss probability, is the shortcoming that default or loss is held realized at the event of default (or catastrophe) whereas default is followed by recovery, and a catastrophic event by loss development. Hence, the invention specifies a modified lattice incorporating the recovery and development.

Given that the insured depository banks pay insurance fees to the FDIC's BIF, and given that the Property & Casualty insurance industry has a shortage of underwriting capacity with respect to the prospect of severe catastrophic losses, and because the taxpaying public stands as the end guarantor against catastrophic bank depository default and catastrophic loss, presented herein is a swap transaction between the quasi-governmental bodies of the FDIC and the NAIC, between insured depository default and catastrophic loss, useful on industry

treaty or per individual institution basis. Specified therein is the use of public sector capital. Such swap or treaty reinsurance provides a mechanism towards open market reinsurance of such relatively uncorrelated risks between the insured banking and P&C insurance industries.

Among the aspects of the invention are specifications of computerized apparatuses and systems to performing valuation, analysis, identification and execution of transactions. Further aspects of the invention include improvements to the art of computational calculators. Such improvements include resident educational features for teaching and scholastic usage. Specified in functional detail is a financial engineering calculator, with computational and resident coded features suitable to the demanding needs of the technical financial community. To date, the prior art financial calculators provide only few rudimentary resident algorithms and lack resident reference resource type items, these shortcomings directly addressed herein.

Please replace the Entire Paragraph beginning on line 1 page 38, which begins "Theta Modeling Technology with Mathematical Functions and Numerical Techniques", with:

Theta Modeling Technology with Mathematical Functions and Numerical Techniques respective an Underlying State Variable, Theta, wherein, an investment or derivative security is modeled by using a single underlying state variable, such a theta variable, insured deposits closed. These have a positive nominal value, an actual amount of cash value. This underlying state variable, theta, θ, is held to follow an independent Markov process: $d\theta/\theta = m\,dt + s\,dz$.

This asserts that the future value of θ depends on the known present values under a continuous pricing constraint. As Wiener process, dz is related to dt: $\Delta z = \varepsilon\sqrt{\Delta t}$.

Such theta variable depends solely on itself and time to define its expected drift and volatility, which it redefines through the course of its life. Thus, $d\theta/\theta = m(\theta,t)\,dt + s(\theta,t)\,dz$.

For methods drawing from standard normal distribution, the log of the change of theta over time and/or the log of theta at exercise should have this distribution. The theta approach is useful where a target variable is not the price of a traded security, but it is useful there, too.

To creating a tradable instrument for a theta variable, assigning the function, f, as the price of a security dependent on θ and time. For instance, for the insured banking's variable, the "deposits closed" and "deposit loss" are candidates for industry's theta. For the insured catastrophe dollar risk, they are the "catastrophe loss" and "net statutory underwriting loss". Variables are created from divers theta, such θi, e.g. θb and θc, correlating respective losses.

For instance, for θ(banking: of insured deposits closed or net deposit losses) and θ (cat: of insured catastrophe or net statutory underwriting losses), let f(b) and f(c) be the respective price of a derivative security with payoff equal to a functional mapping of θb and θc into the future. Let the processes of f(b) and f(c) be defined via Ito's lemma, where

$df/f = \mu\,dt + \sigma\,dz$. This stands for any f(theta).

On a continuous time basis, the change in the price of security (f) dependent on the banking losses is $df(b) = \mu b\, fb\, dt + \sigma b\, fb\, dz$; (and for θc: $df(c) = \mu c\, fc\, dt + \sigma c\, fc\, dz$). An instantaneously riskless portfolio can be created from a combination of related f(bi), such that $(\mu 1 - r)/\sigma 1 = (\mu 2 - r)/\sigma 2 = \lambda$, where r = the present spot, risk-free interest rate at time1 and 2.

Thus, for any f, being the price of a security dependent on only θ and time, with

$df = \mu f\, dt + \sigma f\, dz$, there is the parameter lambda, $\lambda = (\mu - r)/\sigma$, which is dependent on θ and time, but not on the security f, estimating the market pricing of risk of θ by stochastics.

The theta variable's μ is the expected return from f. The expected drift, mu, equals μf. Sigma, σf, is the volatility of $f(\theta)$, and either positively ($df/d\theta>0$) or negatively correlates to θ. If negatively correlated, volatility = $-\sigma$, and df = mu dt + $(-\sigma)$ f (-dz). Variance is [(σ^2)(f^2)] and dz is over an independent interval, dt = (T-t). Using Ito's lemma, the parameter, mu, relating μ and the pricing function, is set as μ* f = df/dt + m θ df/dθ + ½ s^2 θ^2 $d^2f/d\theta^2$.

The parameter Sigma is set, σ * f = s θ df/dθ. This results in a differential structure

df/dt + θ df/dθ (m - λ s) + ½ s^2 θ^2 $d^2f/d\theta^2$ = r* f.

This equation can be solved by setting the drift of θ equal to (m - λ s), and discounting expected payoffs at r, the present spot risk-free (usu. U.S. Treasury) interest rate.

Thus, under risk-neutral valuation, the drift of θ is reduced from m, to (m - λ s).

To constructing a valuation lattice, such in discrete time, introducing the notions of

delta, δ = e^(σ*sqrt(Δt)), and of mu = [2*e^(r*Δt)]/[δ + δ^-1].

Hence, σ = ln(δ)/(sqrt Δt). Next, setting values for Δt, sigma, r(t) and θ (where, θ = S, if modeling an equity security), calculating nodes of θ at θ(tk) = [mu^k]*[δ^w(k(w))]*[θo].

Substituting theta (θ) for a security (S), S isomorphic to θ, affording an underlying random walk of w(k(w)), such that if w=(-1,-1,1...), θ(t(3)) = [mu^3]*[δ^(-1)]*[θo].

In lognormal world, this relates: ln θ(tn) = [n * ln mu] + [w(n(w)) * ln δ] + [ln θo]. This results in the equalities: ln δ = σ*(sqrt Δt) and dt = T/n. Substituting and letting k = n, such that tn = T, forms: ln θ(tk) = [n * ln mu] + [w(n(w)) * (σ*sqrt Δt)]/[sqrt n] + [ln θo].

More simply, the expected value of θ, E(ln θ) = ln mu + ln θo.

The variance of θ, Var(ln θ) = (ln δ)^2.

The volatility of θ, Vol(lnθ) = (ln δ)/sqrt Δt.

For a pathing tree, the node value mechanic, $\theta(tn) = [mu^{n}]*[\delta^{w(n(w))}]\ [\theta o]$, using logarithmic transform, node mechanic, $\ln \theta(tn) = [n * \ln mu] + [w(n(w)) * (\ln \delta)] + [\ln \theta o]$.

By the Central Limit Theorem, the term, $w(n(w))/(\text{sqrt } n)$ exhibits strong convergence to the standard normal distribution, $N(0,1)$. The term $[n* \ln mu]$ shows weak convergence to $[(r - ½\,\sigma^{2})*T]$, hence its robust implementation is limited to the rigors of discrete methods.

The term $[\ln \theta(T)]$ is distributed as $[(r - ½\,\sigma^{2})*T] + [N*\sigma*(\text{sqrt } dt)] + [\ln \theta o]$.

Non-log, $[\theta(T)]$ is distributed as: $[\theta o * e^{((r- ½ *\sigma^{2})*T) + (N*\sigma*(\text{sqrt } \Delta t)}]$.

Valuation of a derivative security (S) based upon the state variable theta, example, the European call option, with realizable cashflow only at T, value today of P, with the functional mapping, $f(\theta o) = \max [\theta(T) - K, 0]$, where K is strike price and θ is held substitutable by S. By weak convergence, today's value, $P(\theta)$, based on θ at T, derived over normal distribution:

$$P(\theta) = [\theta o * N\{(rT+\ln(\theta o/K))/(\sigma*(\text{sqrt } dt)) + (1/2\ \sigma*(\text{sqrt } dt))\}] -$$

$$[Ke^{(-rT)} * N\{(rT+\ln(\theta o/K))/(\sigma*(\text{sqrt } dt)) - (1/2\ \sigma*(\text{sqrt } dt))\}].$$

$P = e^{(-rT)} * E(rn)[\theta(T) - K]$, where $E(rn)$ = expected value under risk-neutral conditions.

For any function, f, valuing a derivative security based on theta that pays off $f(T)$ at time T, the expected risk-neutral value is $f = e^{(-rT)} * E(rn)(f(T))$. This requires setting the growth rate of the underlying theta variable in relation to $[m - \lambda*\sigma]$, rather than as m alone.

Thus, risk-neutral valuation for today's value, $P(\theta)$, $P(\theta)=f(\theta)$, of a derivative security paying off $f(T)$ at time T, is equivalent to the risk-free discount over period (0,T) of its expected risk-neutral future pay-out. This narrow evaluation is valid for f only over the continuous segment (0,T), with determinable values of F(0) and F(T). Lattices which sub-divide this segment, are weakened, if their Δt-parameters, i.e. $\Delta t= (T-t)$ with $0<t<T$, are

modeled using analytic values from (0,T) data sets. Any methodology which relies on convergence to a normal distribution for its valuation, for instance, or a sampling therefrom, is strictly consistent only for European-style derivatives, that is, having exercise only at T, but not continuously throughout the segment (0,T). Also, it assumes the security can gain or lose value during (0,T), with the value of the security always non-negative. The payoffs of the θb and θc securities can be European, if these stem from the single terminal condition of theta at T: the selected theta variables are annual aggregates, they begin each year at θ=0 and end the year at T, θ≥0, European (0,T) events. For rigorous risk-neutral valuation, strict conformity can only be assigned under a European-style (0,T)segment, variable and theta-based security. Such a theta can substitute for a continuously traded security after adjusting for the conditions that θ at T = ∑θi, each θi occurring and aggregating discretely over (0,T). For continuous trading, full data along the annual path of such theta over (0,T) are required to be available.

A valuation function, V, for a security or derivative dependent only on theta and time:

V(t,0)=V(t)= Vo* e^{(r- ½ σ^2)t + (N*σ*(sqrt t)], where V(0,T) is identity of θ(0,T).

To constructing a swap, e.g. between the insured deposit losses and catastrophe losses, modeled on theta(b) and theta(c) respectively, each having valuation function, f(b) and f(c) respectively. The value of the swap to the payer of the deposit losses, f(b), assuming the swap of all year-end aggregate losses:

V = e^(-rT) * {E(rn)[f(c)(T) - f(b)(T)]}, where E(rn)= risk-neutral Expectation.

Though a swap is composed of two sides, its value, V, is a single function. Thus, V is a single derivative instrument modeled by the expectation of the two functions, each respective of its own single theta variable. Consequently, this function, V, models a security dependent on unrelated underlying variables, theta(i). Each theta(i) follows a stochastic

process of form: $d\theta/\theta = mi*dt + si*dzi$, with mi and si the expected growth and volatility rates, the dzi being Weiner processes, then substituting V for f, the total loss swap, V, has the form:

$$dV/V = \mu\, dt + \sum[si*dzi]$$, with μ being the expected return of the swap.

Component risk of the return to the theta(i), $\sum[si*dzi]$ are adjusted if theta(i) are correlated.

Brownian motion defines the change in the value of a variable as related to the variable's initial value and characteristic deviation, as well as to distinct random perturbations resonating variance over independent intervals. It is a discrete process that approaches continuous form when the intervals are small and uncorrelated. Pinned simulation fixes an initial and terminal value for the variable, then developing the value path in between.

An expression of theta with respect to time and to Brownian motion, the life of theta over (0,T) and projected Brownian motion in simulation, can be related in derivational form:

$$\theta(t,B) = \theta o * e\text{^}[(r - \tfrac{1}{2}\sigma\text{^}2)t + \sigma * B].$$

This above equation values without preference to risk, obtaining risk-neutral results.

For geometric Brownian motion, the theta variable must be lognormal in functionality (i.e. its natural log values must show distribution in line with a standard normal population). To implementing this when modeling theta of such distribution, as respective of time only:

$$\theta(t) = \theta o * e\text{^}[(r - \tfrac{1}{2}\sigma\text{^}2)t + \sigma * sqrt(t)].$$

The weak convergence by $\Delta\theta(t)$, requires only that the natural log of the change in theta shows a normalized distribution and characteristic variance (not necessarily $\sigma\text{^}2=1$).

Allowing the notation, $\theta(t,B) = \theta o*e\text{^}[(r - \tfrac{1}{2}\sigma\text{^}2)t + \sigma*B]$, the change in $d\theta$, measured at the terminal values (0,T), with t=T-0, can be derived as: $d\theta = \theta(B)dB + [\theta(t) + \tfrac{1}{2}\theta(BB)]dt$;

its partial derivative input parameters:

$\theta(B)$ = d/dB of $\theta(t,B) = \sigma^*\theta$;

$\theta(BB) = \sigma^\wedge 2\ \ \theta$; and $\theta(t)=[r - ½ \sigma^\wedge 2]^*\theta$.

This computes as $d\theta = \sigma^*\theta^*dB+[(r - ½ \sigma^\wedge 2)\theta + (½ \sigma^\wedge 2)\theta]dt$, and can be reduced to:

$d\theta = \sigma^*\theta^*dB + r^*\theta^*dt$.

For normal theta variables, respective only to time and theta:

$\theta(t) = \theta o * e^\wedge[(r- ½ \sigma^\wedge 2)t + (N^*\sigma^*(\text{sqrt } t)]$; and

V(0,T) as the identity of $\theta(0,T)$, V(t,0)=V(t)= Vo * e^[(r- ½ σ^2)t + (N*σ*(sqrt t)]. This requires only that the natural log of the change in theta, hence, in V, has a characteristic, normal distribution. N represents a sampling off the standard normal distribution, e.g. $N=\varepsilon=\phi$.

Monte Carlo simulation is a discrete methodology that is based on the Law of Large Numbers (e.g. in large numbers of sampling sequences). The life of the security is subdivided into n intervals, each of length Δt. Using s≡volatility, and m≡ risk-neutral growth rate, of θ:

$\Delta\theta = m^*\theta^*\Delta t + s^*\theta^*\varepsilon(\sqrt{\Delta t})$, where each simulation run has n drawings, one per Δt.

For a multiple state θ: $\Delta\theta i = mi^*\theta i^*\Delta t + si^*\theta i^*\varepsilon i(\sqrt{\Delta t})$, with θi: $(1 \leq i \leq n)$. If the θi are correlated, implement correlation between the θi, ρik, and also between the εi and ρik.

Please replace the Entire Sentence, line 15 page 4, which reads "Figures 55 through 58 graphically render P&C underwriting and operating performance data." with:

Figures 55 through 58 graphically render processed P&C underwriting and [operating performance] catastrophe data.

Please replace the Entire Paragraph beginning on line 14 page 30, which begins "The data values of each variable or security can be separately processed or processed in tandem...", with:

The data values of each variable or security can be separately processed or processed in tandem with its transformed values, in addition to being processed and graphed within a collection of variables that are evaluated. The Figure 52 graphs the log values of 1972-adjusted data for deposits closed, in tandem with its log delta values. The Figure 53 graphs the log values of the 1972-adjusted data of deposits closed in comparison with deposit losses. The Figure 54 graphs the log delta 1972-adjusted data for deposits closed and for deposit losses. The Figure 55 graphs the actual nominal values of net statutory underwriting <u>and catastrophe losses</u> for the Property & Casualty (P&C) industry on a consolidated basis. The Figure 56 graphically represents the P&C industry's [actual operating results, comprising a number of its key operating variables] <u>1972-adjusted dollar amounts of statutory and catastrophe losses</u>. The Figure 57 charts the [actual nominal values of the P&C surplus and liabilities] <u>log values of the 1972-adjusted data for statutory and catastrophe losses</u>, whereas the Figure 58 charts [additionally the assets, wherein the relative growth of each variable is shown] <u>the log delta 1972-adjusted data</u>. The Figure 59 presents the actual nominal underwriting loss and the loss from catastrophes, revealing the contribution of the later to the overall performance of the P&C underwriting. The Figure 60 graphically represents the log and delta log values for catastrophe losses, and the Figure 61 charts the log and delta log values for statutory and catastrophe losses. By charting, the trends of the cleaned data variables are visually apparent.

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